integral™
STORAGE
TECHNICAL DATASHEET

Integral P Series 2
SATA II 2.5 Inch

Specification

Rev.A

Features:

- SATA 2.6 Compliant, 3Gb/s support and 1.5Gb/s support
- ATA modes supported
  - PIO modes 3 and 4
  - Multiword DMA modes 0, 1, 2
  - Ultra DMA modes 0, 1, 2, 3, 4, 5, 6
- Industry-standard, 512-byte sector size support
- Hot-plug capable
- Ultra-efficient Block Management & Wear Leveling
- Intelligent “Recycling” for advanced free space management
- RoHS-compliant package
- S.M.A.R.T. (Self-monitoring, analysis, and reporting technology) command set
- Performance (lifetime)[1]
  - Sequential READ: up to 285 MB/s @128K
  - Sequential WRITE: up to 280 MB/s @128K
  - Random READ: up to 30K IOPs @4K
  - Random WRITE: up to 30K IOPs @4K
- Endurance: Total bytes written (TBW)
  - Up to 5PB
- Reliability
  - MTBF(PoH): 2 million device hours[2]
  - Up to 24 9-bit Symbols Correction per 512 9-bit Symbol
  - Static and dynamic wear leveling
  - Non-recoverable Read Errors: (Less than 1 sector per bits read) 10^16
  - Low power consumption: <2.5W (AVE)
- Mechanical/electrical
  - Standard SATA connector
  - 5V power (±10%)
  - 2.5-inch drive: 100.mm x 69.75mm x 9.5mm
  - Weight: 81g
- Operating temperature: 0°C to 70°C
- Humidity (operating): 5% to 95% RH
- Shock and vibe
  - 1500G/0.5ms
  - 2–500Hz at 3.1G
- Capacity: 60GB, 120GB, 240GB

Notes: 1. Typical I/O performance numbers as measured using Iometer with a queue depth of 32 and write cache enabled.
2. The product shall achieve a mean time between failure (MTBF) of 2.0 million hours, which are based on population statistics that are not relevant to individual units.
3. 1GB = 1 billion bytes (1000^4)

Dimensions

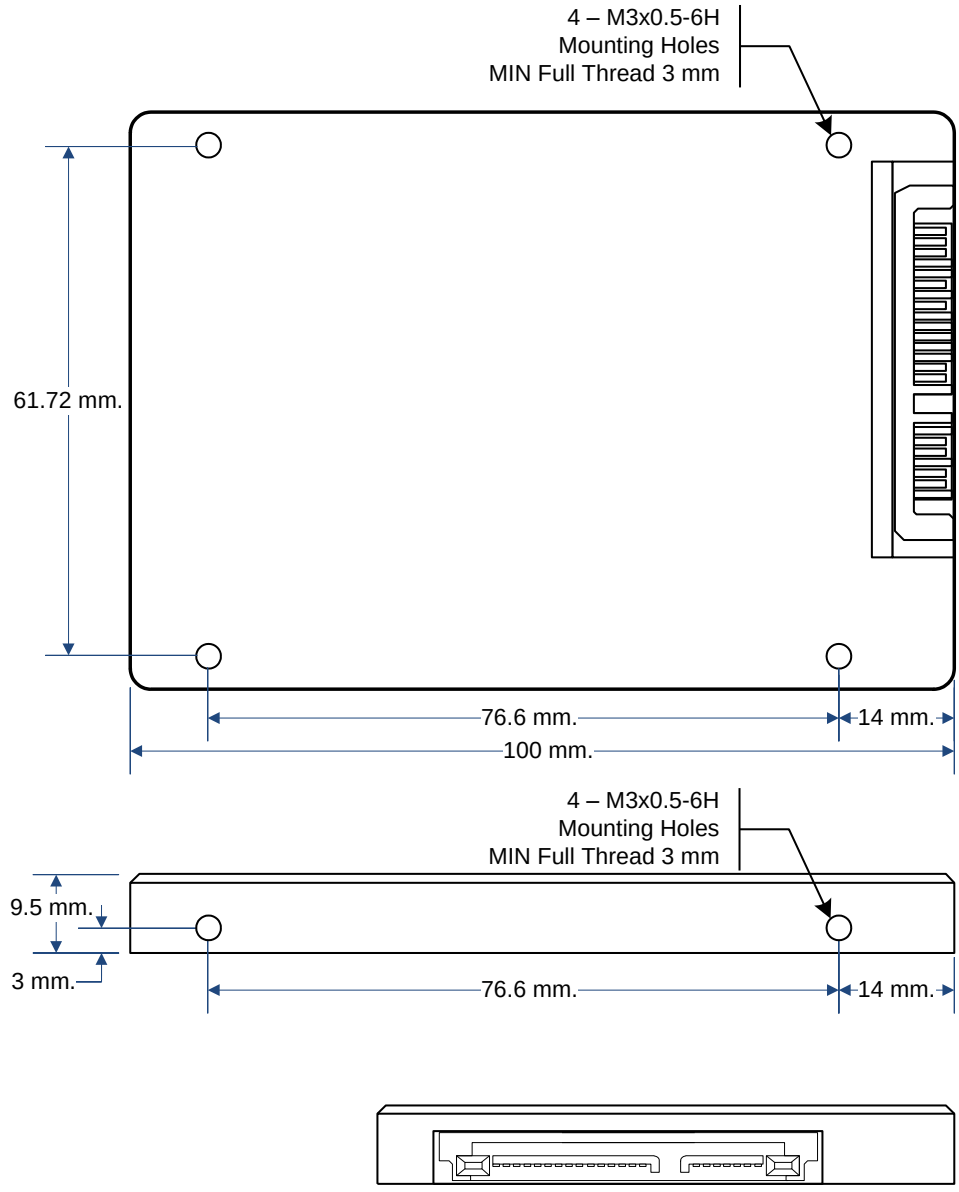

Figure 1 Integral P Series 2 SATA 2.5" SSD Housing

Architecture

Integral's solid state drive (SSD) employs a single-chip controller with a SATA interface on the system side and up to 16-channels of NAND Flash internally.

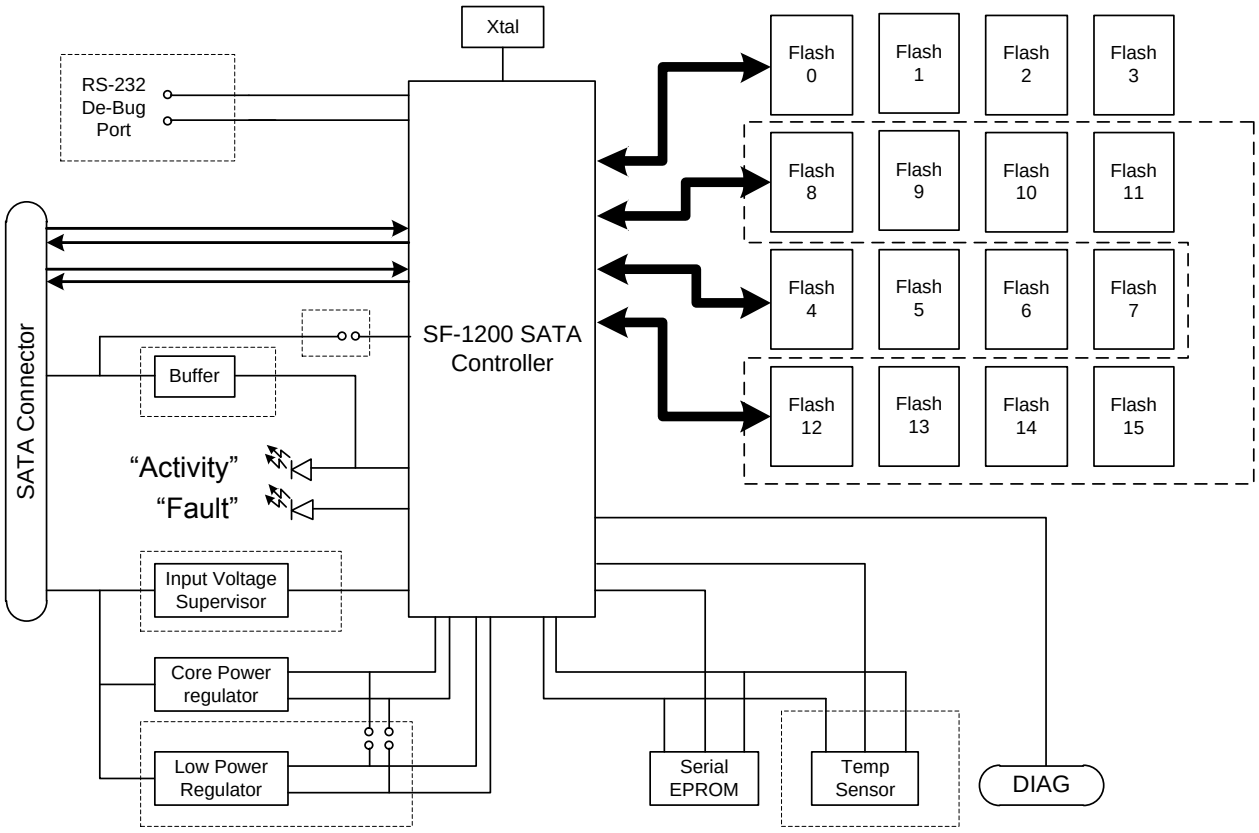

Figure 2 – SATA Connections

Logical Block Address Configuration

The drive is set to report the number of logical block addresses (LBA) that will ensure sufficient storage space for the specified density. Standard LBA settings, based on the IDEMA standard (LBA1-02), are shown below.

Capacity

The capacity is reported as a decimal count of Bytes. The capacity is determined using the industry standard method as defined by the International Drive Equipment Manufacturers Association (IDEMA).

Drive capacity is calculated with the following equation:

SSD Capacity in Gbytes = (UserAddressableLBAcount - 21168) / 1953504

Equation 1 IDEMA user capacity calculation

Table 1 Integral P Series 2 SSD drive Configurations

User Capacity (1000^4)	Raw Capacity (1024^4)	Wear Level Provisioning	LBA Count
60	64	7%	117,231,408
120	128	7%	234,441,648
240	256	7%	468,862,128

Performance

Table 2 Integral P Series 2 SSD Drive Configurations

	Sequential		Random		Access
User Capacity (1000^4)	Read (MB/s)	Write (MB/s)	Read (IOPS)	Write (IOPS)	
60	285	275	>30K	>30K	<100 µsec
120	285	275	>30K	>30K	<100 µsec
240	285	275	>30K	>30K	<100 µsec

Table 3 Nominal Dimensions and Weights

Signal Name	Type	Description
Height	9.5	mm
Width	69.85	mm
Length	100	mm
Unit weight	81	g

Interface Connectors

Integral SSD uses the industry standard 2.5” SATA connector as defined by SATA-IO. The pin-out of the signal segment is shown in Table 4 and the pin-out of the power segment is shown in Table 5.

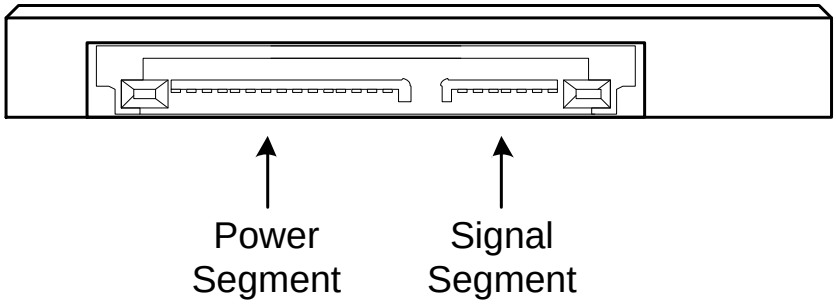

Figure 3 – SATA Connections

Table 4 Signal Segment pin assignments

Signal Name	Type	Description
S1	GND	Ground
S2	A+	A+ (transmit)
S3	A-	A- (transmit)
S4	GND	Ground
S5	B-	B- (receive)
S6	B+	B+ (receive)
S7	GND	Ground

Table 5 2.5-Inch SATA Power Segment Pin Assignments

Signal Name	Type	Description
P1	V33	No connect
P2	V33	No connect
P3	V33	No connect
P4	GND	Ground
P5	GND	Ground
P6	GND	Ground
P7	V5	5V power
P8	V5	5V power
P9	V5	5V power
P10	GND	Ground
P11	DAS	Device activity signal
P12	GND	Ground
P13	V12	No connect
P14	V12	No connect
P15	V12	No connect

Note: 1. The DAS signal may be optionally connected to GND if an LED is not being used.

Commands

Table 6 Supported ATA Command Set

Command Name	Command Code (hex)	Description
CHECK POWER MODE	0x98	
CHECK POWER MODE	0xE5	
DEVICE CONFIGURATION	0xB1	
FLUSH CACHE	0xE7	
FLUSH CACHE EXT	0xEA	
IDLE	0xE3	
IDLE	0x97	
IDLE IMMEDIATE	0x95	
IDLE IMMEDIATE	0xE1	
NOP	0x00	
READ BUFFER	0xe4	
READ BUFFER DMA	0xe9	
READ DMA	0xc8	
READ DMA EXT	0x25	
READ DMA (without retries)	0xc9	
READ FPDMA QUEUED	0x60	
READ LOG DMA EXT	0x47	
READ LOG EXT	0x2F	
READ MULTIPLE	0xc4	
READ MULTIPLE EXT	0x29	
READ NATIVE MAX ADDRESS	0xF8	
READ NATIVE MAX ADDRESS EXT	0x27	
READ SECTORS	0x20	
READ SECTORS EXT	0x24	
READ SECTORS (without retry)	0x21	
READ VERIFY SECTORS	0x40	
READ VERIFY SECTORS EXT	0x42	
READ VERIFY SECTORS (without retry)	0x41	
RECALIBRATE	0x10	
REQUEST SENSE DATA EXT	0x0B	
SECURITY DISABLE PASSWORD	0xF6	
SECURITY ERASE PREPARE	0xF3	
SECURITY ERASE UNIT	0xF4	
SECURITY FREEZE LOCK	0xF5	
SECURITY SET PASSWORD	0xF1	
SECURITY UNLOCK	0xF2	
SEEK	0x70	
SET FEATURES	0xEF	
SET MAX ADDRESS	0xF9	
SET MULTIPLE MODE	0xC6	
SET NATIVE MAX ADDRESS EXT	0x37	
SLEEP	0x99	
SLEEP	0xE6	
SMART	0xB0	
STANDBY	0xE2	
STANDBY	0x96	
STANDBY IMMEDIATE	0x94	
STANDBY IMMEDIATE	0xE0	
WRITE BUFFER	0xE8	
WRITE BUFFER DMA	0xEB	
WRITE DMA	0xCA	
WRITE DMA EXT	0x35	

WRITE DMA FUA EXT	0x3D	
WRITE DMA (without retries)	0xCB	
WRITE FPDMA QUEUED	0x61	
WRITE LOG DMA EXT	0x57	
WRITE LOG EXT	0x3F	
WRITE MULTIPLE	0xC5	
WRITE MULTIPLE EXT	0x39	
WRITE MULTIPLE FUA EXT	0xCE	
WRITE SECTORS	0x30	
WRITE SECTORS EXT	0x34	
WRITE SECTORS (without retry)	0x31	

Smart Attributes

Table 7 S.M.A.R.T Attributes

Reliability Tracking		Mobile – P Series 2
1	Raw Read Error Rate	X
5	Retired Block Count	X
13	Soft Read Error Rate	
171/181	Program Fail Count	X
172/182	Erase Fail Count	X
184	IOEDC Errors	
187	Reported Uncorrectable Errors	X
195	ECC On-the-fly Count	X
196	Reallocation Event Count	X
198	Uncorrectable Sector Count	
199	SATA R-Errors Error Count	
201	Uncorrectable Soft Read Error Rate	X
204	Soft ECC Correction Rate (RAISE)	X
Usage Statistics		
9	Power On Hours	X
12	Device Power Cycle Count	X
100	Gigabytes Erased	
241	Lifetime Writes from Host	X
242	Lifetime Reads from Host	X
Life Remaining		
170	Reserved Block Count	
231	SSD Life Left	X
232	Available Reserved Space	
Power Loss		
174	Unexpected Power Loss	X
235	Supercap Monitoring	
Wear Leveling		
177	Wear Range Delta	X
Temperature		
194	Temperature	X
Warranty Life Throttling		
230	Life Curve Status	
Other		
233	Internal Reserved	X
234	Internal Reserved	X

Reliability

Integral SSDs incorporate advanced technology for defect and error management. The Controller uses various combinations of redundant storage elements, hardware-based error correction algorithms and firmware-based static and dynamic wear-leveling algorithms.

Over the life of the SSD, uncorrectable errors may occur. An uncorrectable error is defined as data that is reported as successfully programmed to the SSD but when it is read out of the SSD, the data differs from what was programmed.

Table 8 Uncorrectable Bit Error Rate

Uncorrectable Bit Error Rate	Operation	
<1 sector per 10^{16} bits read	Read	

The product life is at least 5 years or 43,800 power-on hours, whichever comes earlier under the following conditions:

- Power-on hours = 8,760 per year
- Operating time = 100% of power-on hours
- Active/Idle duty cycle = 90% of the time
- Environmental = temperature, altitude, humidity and voltage within operating ranges
- The drive should be protected from electrostatic discharge (ESD)
- The product life does not represent any warranty or warranty period. Applicable warranty and warranty period are covered by the purchasing agreement.
- Note: Product life is defined as time in service at systems conditions while maintaining compliance to the MTTF specification for the device.

Mean Time Between Failures

Mean time between failures (MTBFs) for the SSD can be predicted based on the component reliability data using the methods referenced in the Telcordia SR-332 reliability prediction procedures for electronic equipment.

Table 9 Drive MTBFs

Density	MTBF (Operating Hours)[1]	
60	1.5 million	
120	1.5 million	
240	1.5 million	

Note: 1. A mean time between failure (MTBF) of 2.0 million hours is based on population statistics that are not relevant to individual units.

Preventive Maintenance

Not Applicable. No preventative maintenance is required.

Unauthorized maintenance to the SSD will void the warranty.

Endurance

The endurance is a function of the PE cycles of the flash devices used, the Write Amplification (WA) of the controller and the usage model of the application. Table 10 gives the Write life in TeraBytes (TB) for the best case WA for the Controller used in this Integral SSD drive and a WA that is more typical of other drives in the industry.

Actual WA for a particular application can be determined using the S.M.A.R.T. attributes.

Table 10 Drive lifetime

User Capacity	Standard MLC based part numbers	Write Life w/MLC	
		WA=.5 (TB)	WA=6 (TB)
60	INSSD60GS25MXP2	640	53.3
120	INSSD120GS25MXP2	1280	106.7
240	INSSD240GS25MXP2	2560	213

Electrical Characteristics

Table 11 SATA Typical Power Consumption

Density	Idle	Idle w/DIPM	Sequential Write/Read
60	64	7%	117,231,408
120	128	7%	234,441,648
240	256	7%	468,862,128

Table 12 Absolute Maximum Ratings

Condition	Symbol	Min	Max	Unit
Voltage Input	Vs	3.3	5.5	V
Operating Temperature	T_A	0	70	C
Non-operating Temperature		-40	85	C
Relative Humidity		5	95	%

Table 13 Shock and Vibration

Condition	Specification
Operating shock	1500 G / 0.5ms
Operating Vibration	2-500 Hz at 3.1G

Compliance

Integral SSDs comply with the following:

- RoHS “green”
- CE (Europe): EN55022, 2006 Class B and EN55024, 1998 + A1: 2001 + A2:2003
- FCC: CFR Title 47, Part 15, ICES-003, all Class B